

## **EXHIBIT 2**

MALCOLM  
PIRNIE

*Miles,  
let us know if  
you have any questions?  
Thanks!  
Mark*

TECHNICAL  
MEMORANDUM

To: M. Moffatt, NYC

Date: September 24, 1999

From: M. Lenz &amp; K. Naraghi, NYC

Re: Brooklyn-Queens Aquifer Project - Station 6 Modifications

**1.0 Introduction****1.1 Project Purpose:**

The purpose of this project is to demonstrate that the existing groundwater system can be expanded to supply consistent, good quality water from the Brooklyn-Queens Aquifer as part of an overall Groundwater Management approach. This project will provide a reliable supplemental source of water to New York City Department of Environmental Protection's (DEP) Catskill/Delaware and Croton (Upstate) supplies. The proposed modifications at Station 6 include rehabilitation of the existing wells and existing treatment processes. The modifications will incorporate as much of the existing infrastructure (buildings, pump houses, tanks, piping, and pumps) as possible. The groundwater supply will be treated at Station 6 and introduced into the local distribution system. These modifications will demonstrate current treatment technologies which can be employed to consistently produce high quality drinking water. This project will also demonstrate the applicability of regional water treatment plants as part of the larger Brooklyn-Queens project, and how their use could reduce demand for "Upstate" water within these two boroughs.

**1.2 Project Concept:**

Currently, there are several inactive wells in the Station 6 area that have been used, with varying degrees of treatment, to provide potable water. Of these wells, only one is currently in use, therefore the first phase of the project will focus on rehabilitating all of these wells so that they can provide a reliable supply of groundwater to the water treatment plant. It is expected that this will allow up to 6 wells to provide 6 - 9 mgd of groundwater to the treatment plant. The second phase of the project will rehabilitate the existing treatment plant; and where applicable, incorporate new technologies and unit processes to ensure that a reliable high quality water is consistently produced and delivered to the distribution system. Treatment technologies will demonstrate that the groundwater from the Brooklyn-Queens Aquifer can meet or exceed New York State Department of Health (NYSDOH) and Federal Environmental Protection Agency (EPA) Drinking Water Standards. This project will not be a major expansion of the existing NYCDEP Groundwater System, which might require specific environmental analyses under City Environmental Quality Review (CEQR) guidelines, but rather portions of the existing system will be utilized with specific components receiving significant upgrades.

**1.3 History of Station 6:**

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There are four existing wells (6, 6A, 6B, and 6D) at Station 6 tapping the Upper Glacial Aquifer which ranges from 73 to 92 feet thick at this location. A fifth well (33), located off-site but within the vicinity of the other wells, also taps the Upper Glacial Aquifer and is the only well being considered for a supply that is currently in operation, pumping at 200 gpm. A sixth well (6C), is also located at Station 6, but taps the Lloyd Aquifer which is well below and hydraulically separated from the Upper Glacial by approximately 400 feet at this location.

Table 2-1 provides a summary of the reported historical yield and the optimized anticipated yields of the wells which are intended to feed the Demonstration Plant at Station 6. Anticipated yields are based on Scenario P, as described in the attached groundwater modeling memorandum.

Table 2-1: Historical and Anticipated Production of Wells

Well #	Historical Yield (from Well Logs) (gpm/MGD)	Anticipated Production (from 5/99 Modeling) (gpm/MGD)	Aquifer Tapped
6	1200 / 1.73	→ 500 / 0.72	Upper Glacial
6A	1200 / 1.73	1500 / 2.16	Upper Glacial
6B	1200 / 1.73	900 / 1.30	Upper Glacial
6D	800 / 1.15	→ 500 / 0.72	Upper Glacial
33	1000 / 1.44	1400 / 2.02	Upper Glacial
6C	1800/2.60 (logs) or 2100 / 3.02 (6/96 data)	N/A ~2000 gpm	Lloyd

The total average anticipated inflow to the treatment plant from the Upper Glacial Aquifer wells is 4800 gpm, or 6.9 MGD. An additional volume of water could be supplied by redeveloping the deeper Lloyd Aquifer well (6C). However, redeveloping the Lloyd Aquifer will require further study, as this Aquifer generally has strict controls placed on it by New York State Department of Environmental Conservation (NYSDEC) to protect the shore communities who rely on this aquifer as their sole source of potable water.

Using Well 6C (the Lloyd well) would bring the average baseflow (assuming it was developed to historical levels) above 9 mgd. Besides additional flow from the Lloyd, there is also the possibility that the Upper Glacial wells may be pumped at a higher rate for short periods of time to help meet the seasonal demand. Designing the plant for a flow capacity of 9 mgd, would allow for a 35% increase in inflow in anticipation of either meeting the seasonal demands or adding flow from the Lloyd well.

## 2.2 Existing Distribution System & Pressure Zones:

There is an existing 20" discharge line from the pump room in Station 6 which connects into a 24" distribution main on Brooklyn Avenue (164th Place). The 24" distribution main connects to two 12-

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inch lines once it reaches 109th Avenue (Pacific Street) and then the 24" main continues north towards 108th Drive.

Assuming the 20" pipe leaving Station 6 carries water at 7-8 ft/sec, it will have a hydraulic capacity of approximately 6800-7800 gpm (9.8 - 11.2 mgd). The distribution system surrounding the plant is a low pressure zone. Assuming this is similar to a regulated low zone, pressures would be equivalent to approximately 150 feet (65 psi).

### 2.3 Existing Station 6 Storage, Supply, and Pumping:

There are two existing storage tanks at Station 6, one with 1,000,000 gallon capacity (Tank No. 17) and another with 825,000 gallon capacity (Tank No. 27). Both are located north of the booster pump building. These tanks are filled with Upstate water from the distribution system (typically after midnight), and then pumped back into the local distribution system via the booster pumps during periods of high demand (typically 6am-9am & 3pm-8pm). These tanks do not contain any baffles or intake pipes for increasing residence time within the tanks and suction is from the bottom of the tanks.

The current booster station configuration is one-1,000 gpm, one-2,000 gpm, and one-3,500 gpm pump. Normally, only the 2,000 gpm pump is required. As demand increases, the 1,000 gpm pump is also activated, and during very high demand (fire protection situations) the 3,500 gpm pump is also activated. Based on information at this time, the existing pumps, storage tanks, and connection line would have sufficient hydraulic capacity to move the anticipated quantity of water from the Demonstration Plant into the distribution system.

## 3.0 Water Quality

### 3.1 Historical Volatile Organic Compound (VOC) Levels in Station 6 Area:

Several volatile organic compounds have been detected in the groundwater system in the vicinity of Station 6. The available data from the supply wells is listed in Table 3-1. It is reported here and used for a conceptual evaluation of the treatment process; however, it is anticipated that other organics will be found in the groundwater at possibly higher levels. It is anticipated that additional water quality data will be collected for use in the preliminary and final design of the treatment plant.

Table 3-1: Historical Volatile Organic Compounds Detected

Well#	Sample Date	Volatile Organic Compound	Concentration (ug/L)	NYSDOH MCL* (ug/L)
6	4/6/82	Tetrachloroethylene (PCE)	260	5
6D	9/29/88	1,1,2,2-tetrachloroethane	78	5(?)
6D	9/29/88	cis-1,2 dichloroethene	29	5

\*NYSDOH MCL: New York State Department of Health Maximum Contaminant Level

*Add discussion of tetrachloroethane*

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Tetrachloroethylene, a suspected carcinogen, is chiefly used in dry cleaning and in the textile industry. It is used as a solvent, heat transfer medium, and in the manufacture of fluorocarbons. Tetrachloroethylene (PCE) has been detected at concentrations as high as 50,000 ug/L in groundwater at the West Side Corporation, a NYSDEC Class II hazardous waste site located at 107-10 180<sup>th</sup> Street which is within a mile of Station 6.

Dichloroethene has a variety of industrial uses. It is used as a solvent for various waxes and resins, and as a refrigerant. It is also a breakdown product of tetrachloroethylene. Dichloroethene impacts the circulatory system and depresses the central nervous system.

### 3.2 Historical Iron & Manganese Levels in Station 6 Area:

Based on historical water quality data from the Jamaica Water Supply Company, iron and manganese levels appear to be well over the mandated State and Federal limits. These elements are often found naturally occurring together in groundwater. Iron and manganese are classified as secondary water quality parameters under federal guidelines with a limit of 0.3 mg/l for Fe and 0.05 mg/l for Mn (0.3 mg/l combined). However, New York State classifies these two compounds as primary drinking water concerns, with limits of 0.30 mg/l for Mn and 0.30 mg/l for Fe (0.5 mg/l combined). When present in high concentrations, these compounds can cause undesirable color, odor, and taste in the water. Staining of laundry and washing facilities can occur when these compounds are oxidized within the distribution system or residents' homes. High levels of iron and manganese, if left untreated, can promote growth of "iron bacteria" which can further affect the water supply's taste and odor.

Table 3-2 presents available water quality data on iron and manganese:

Table 3-2: Historical Iron (Fe) and Manganese (Mn) Concentrations

Well	Anticipated Yield (gpm)	Avg. Fe (mg/L)	Max. Fe (mg/L)	Avg. Mn (mg/L)	Max. Mn (mg/L)
6	500	3.91	5.2	1.19	1.6
6A	1500	6.68	9.22	1.92	2.32
6B*	900	N/A*	N/A*	N/A*	N/A*
6C	0 or 1800	2.89	3.2	0.11	0.12
6D	500	2.7	3.5	0.54	0.74
33	1400	0.95	1.4	0.53	0.68

\* No samples taken - no data available

Two flow weighted average influent iron concentrations were calculated, depending on whether the Lloyd Aquifer well was off-line (Total plant flow of 6.9 mgd) or on-line (Total flow 9.5 mgd). The flow weighted iron concentrations are 3.76 mg/L at 6.9 mgd and 3.48 mg/L at 9.5 mgd; the NYSDOH limit for iron is 0.30 mg/L. Similarly, the two weighted average manganese concentrations (based on

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expected yield flow data) are 1.15 mg/L at 6.9 mgd or 0.82 mg/L at 9.5 mgd; the Federal limit for manganese is 0.05 mg/L.

### 3.3 Other Parameters of Concern in Station 6 Area:

Besides the volatile organic compounds, iron, and manganese, other historical water quality data is available for the wells which will feed the Demonstration Plant. This data includes turbidity, color, sodium, chloride, total dissolved solids (TDS), nitrate, odor, pH and sulfate.

The data show that turbidity and color are above their NYSDOH limits. Both parameters are likely related to the iron and manganese concentrations and will be controlled through the same treatment processes. Sodium is below the limit for those on a moderate sodium diet (200 mg/L) but slightly higher than the limit for those on a severely restricted sodium diet (20 mg/L). Chloride and nitrate are both below their NYSDOH limits, although the nitrate ( $\text{NO}_3^-$ ) concentration (based on a flow-weighted average) is within an order of magnitude of the limit (5.05 mg/L or 3.49 mg/L versus 10 mg/L limit), and the maximum recorded value (7.7 mg/l) was only 23% below the MCL. Nitrates are of concern in drinking water because of their potential toxicity, especially to infants (methemoglobinemia). Odor is described as mostly "musty", with Well #33 also having an "organic" odor. Both sulfate and total dissolved solids are below the NYSDOH limits. The average influent pH (6.1 or 6.0), is below the desired range of 6.5 to 8.5 and will need to be raised to facilitate the proposed treatment processes. Table 3-3 presents the average water quality data currently available for the Station 6 wells.

Table 3-3: Comprehensive Water Quality Data for Station 6 Wells

Water Quality Parameter	Well #6	Well #6A	Well #6B	Well #6C	Well #6D	Well #33	Influent @ 6.9 mgd	Influent @ 9.5 mgd	NYSDOH/EPA Limits
Iron (mg/L)	3.91	6.68	N/A*	2.89	2.70	0.95	3.76	3.48	0.30
Manganese (mg/L)	1.19	1.92	N/A*	0.11	0.54	0.53	1.15	0.82	0.05
Turbidity (NTU)	21	28	N/A*	1.25	21	6.65	18.54	13.08	0.2 - 0.5
Sodium (mg/L)	28	32	N/A*	8	30	31	31	24	20 / 200
Chloride (mg/L)	51	47	N/A*	6	49	52	50	36	250
Color	32	43	N/A*	6	38	20	33	24	15
TDS (mg/L)	372	350	N/A*	57	375	524	418	304	500
Nitrate (mg/L)	5.50	4	N/A*	0.10	6.50	5.50	5.05	3.49	10.00
pH	6.05	5.90	N/A*	5.85	6.15	6.40	6.13	6.04	6.5 - 8.5
Sulfate (mg/L)	115	114	N/A*	16	92	139	120	87	250

\* No samples taken - no data available

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### 3.4 Other Contaminants of Concern Within the Aquifer:

Beyond the contaminants that have been detected in the Station 6 wells, there are other pollutants of concern that have been found in the aquifer in other areas. These other contaminants may be present in the raw water when the wells are pumped over the long term.

The presence of methyl-tertbutyl-ether (MTBE) is a widespread concern. MTBE is a gasoline additive that serves to oxygenate fuel to reduce carbon monoxide emissions. However, it is highly soluble and is commonly found as a groundwater contaminant associated with spills and releases from gas stations. Although not typically included in historical water analyses, MTBE was detected in two wells in Brooklyn in 1992. More recently however, MTBE is included in water analyses and its detection has become widespread in urban areas. Several of the old Jamaica Water Supply Company (JWSC) wells in Queens were taken out of service due to the presence of MTBE.

Although MTBE is not currently regulated, the NYSDOH recently completed a risk assessment and recommended that the NYSDEC set a very low MCL or action level for MTBE. Considering that numerous potential sources of MTBE exist within 1 mile of Station 6, the need to treat for MTBE should be anticipated, particularly in conjunction with the high concentrations of PCE reported nearby. Trichloroethylene (TCE) is another VOC that is anticipated to be present in the Station 6 wells. TCE is used as a solvent commonly used to clean electronic parts and it is a suspected carcinogen.

Salt water intrusion to the aquifers has historically been of concern. At concentrations above 250 mg/L, drinking water may have a salty taste from the formation of sodium chloride. Chloride exceedances from 1981, 1983, and 1992 in both industrial and monitoring wells were concentrated around Jamaica Bay, Flushing Bay, and tributaries of the East River. However, Station 6 is located inland, and the groundwater modeling results show that salt water intrusion is not expected to be a problem at the proposed pumping rates for the Station 6 modifications.

The presence of metals is also a water quality concern. Cadmium exceedances were found in 1992 in two industrial wells; cadmium concentrations exceeding NYSDOH MCL limits were found that same year in three separate USGS monitoring wells. Chromium exceedances were detected in four USGS monitoring wells in 1992. Chromium compounds, which have various uses in the manufacture of metal alloys, are extremely persistent in aquatic environments. Lead is another chemical of concern: it can result in a variety of adverse effects to human health and is often the result of corrosion of materials present in the water distribution system. Lead exceedances were found in certain USGS monitoring wells during a 1992 sampling program. Mercury was detected in an industrial well in Brooklyn during a 1983 sampling event. Mercury, which is used in the manufacture of batteries and electrical switches, can result in kidney damage. Zinc may cause undesirable taste and odor in water. Zinc exceedances were found in 1992 samples taken from USGS industrial wells.

Table 3-4 shows the locations of monitoring well and industrial well sampling sites within a two-mile radius of Station 6, listed in order of proximity to the Station 6 site. As no data on metals is available

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for the Station 6 wells it is not being considered in the current process train. As additional sampling is done during the preliminary design, the treatment train will be adjusted accordingly.

Table 3-4: Metals Exceedances within Station 6 Zone

Sample ID	Aquifer	Date	Cadmium (mg/L)	Copper (mg/L)	Mercury (mg/L)	Zinc (mg/L)	Chromium (mg/L)	Lead (mg/L)
USGS Monitoring Well Sample Sites Within Station 6 Zone: (in order of closest to farthest)								
Q2324	Upper Glacial	6/6/83	10	100	<1	n/a	30	30
Q1237	Jameco	10/6/83	10	20	<1	60	30	30
Q3150	Jameco	6/21/83	10	70	<1	200	30	30
Q3117	Upper Glacial	8/15/83	10	90	<1	100	30	40
Q3112	Jameco	8/15/83	10	50	<1	70	30	30
Q3109	Magothy	8/18/83	10	20	<1	80	30	30
Q3115	Upper Glacial	7/18/83	20	n/a	<1	90	30	350
USGS Industrial Well Sample Sites Within Station 6 Zone: (in order of closest to farthest)								
Q2289	Jameco	7/27/83	10	10	<1	50	30	30
Q2384	Jameco	7/27/83	10	200	<1	60	30	30
Q1506	Upper Glacial	8/9/83	10	80	<1	120	30	100
NYSDOH Limits (MCL):			0.005	1.3	0.002	5	0.1	0.015

Q = Queens County; K = Kings County

Add discussion of UG wells from "18g Report"

Based on the water quality data available throughout Brooklyn and Queens, the average hardness levels found in the groundwater supply are expected to be within a range of customer acceptability. The total hardness of the DEP Groundwater wells ranges from 30 to 474 mg/L as CaCO<sub>3</sub>, with average hardness being approximately 144 mg/L. However, even if the hardness levels in the wells are within regulatory limits, there may be a difference noted by the consumers because their current supply is the 'very soft' (~18 mg/L) Catskill/Delaware surface water. Hardness reduction can be an expensive treatment option, but might potentially be needed for consumer satisfaction. However, this determination will not be made until additional data is available for the preliminary design.

### 3.5 Federal & New York State Water Treatment Standards:

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The modifications at Station 6 will be designed to meet New York State Department of Health (NYSDOH) State Sanitary Code and Federal US Environmental Protection Agency (EPA) Drinking Water Standards. Regulations and standards which will be reviewed for compliance include, but are not limited to, National Interim Primary Drinking Water Regulations (NIPDWR), Secondary Maximum Contaminant Levels (SMCLs), Groundwater Disinfection Rule (GWDR), Total Coliform Rule (TCR), Disinfectant/Disinfection By-Products Rule (D/DBP Rule), Lead and Copper Rule (LCR), Phase I, Phase II, & Phase V Inorganic Compounds (IOCs), Volatile Organic Compounds (VOCs), Synthetic Organic Compounds (SOCs), and Ten State Standards. The following table summarizes the major Federal and New York State water treatment standards (please note that the Phase IOCs, SOCs, and VOCs are not included in the table below):

Table 3-3: Federal and New York State Water Treatment Standards

Parameters (unit)	NYSDOH MCL	USEPA MCLG*	Parameters (unit)	NYSDOH MCL	USEPA MCLG*
Cadmium (mg/L)	0.005	0.005	Mercury (mg/L)	0.002	0.002
Chloride (mg/L)	250	250	Nitrate (mg/L nitrogen)	10	10
Chromium (mg/L)	0.1	0.1	pH	6.5-8.5	-
Color (color units)	15	-	Sodium (mg/L) ( $< 20$ for severely restricted diets)	$< 270$ (moderate)	-
Copper (mg/L)	1.3	1.3	Sulfate (mg/L)	250	250
Iron (mg/L)	0.3	0.3	Total Dissolved Solids (TDS) (mg/L)	500	500
Lead (mg/L)	0.015	0.05	Turbidity (units)	5	-
Manganese (mg/L)	0.3	0.05	Zinc (mg/L)	5	5

\* MCLG: Maximum Contaminant Level Goal

### 3.6 Anticipated Process Train:

The modifications at Station 6 will equip the water treatment plant for removal of iron, manganese, and VOC's, while also chemically treating the water for potable distribution. The following paragraphs briefly describe the proposed process train. Figure 3-1 shows a conceptual schematic of the water treatment plant.

Iron and manganese concentrations will be reduced through the process of aeration, chemical oxidation, and filtration. Raw water entering the Demonstration Plant will be routed through forced draft aerators to add oxygen and reduce carbon dioxide and volatile organics. Addition of sodium hydroxide will raise the pH (aiding in Fe and Mn removal), while addition of sodium hypochlorite will further promote oxidation and precipitation of iron and manganese compounds. After sufficient contact time in a detention basin, the water will be pumped through manganese greensand pressure filters, which will serve to oxidize the remaining soluble iron and manganese and remove the iron and

manganese precipitates. These filters will be continually regenerated through a potassium permanganate feed (upstream of the detention basin) and regularly backwashed to remove particulates.

The volatile organic compounds will be removed through the use of packed column air strippers. The water will be pumped to the top of a media-filled column and allowed to trickle down against counter-current flow of forced air. The volumetric ratio of air ( $\text{ft}^3$ ) to water ( $\text{ft}^3$ ), commonly referred to as air-water ratio, is a function of the Henry's law coefficient for the compounds. A two-stage system is envisioned: a low air-water ratio (40:1) for the first pass and then a high air-water ratio (150:1) through the second tower to remove the more soluble organics such as MTBE. A by-pass mechanism would allow the treated water to go through only the first air tower if soluble VOC concentrations are low enough in the raw water influent. This mass transfer process (compounds pass from water into the air) allows the air to carry the compounds out of the stripper and to be dissipated into the atmosphere. The presence of highly soluble VOCs such as MTBE will greatly impact the design of the air strippers, as they require much higher air to water ratios for removal (150:1 vs. 40:1).

VOCs in the exhaust gas from the aerators and stripping towers will be subject to state and local regulations, and may require additional treatment prior to discharging to the atmosphere. Air pollutant emissions from stripping towers are typically controlled through vapor-phase carbon adsorbers or thermal incineration. Vapor-phase carbon adsorbers are recommended for this project because: (i) the NYCDEP already uses carbon for VOC control at their Water Pollution Control Plants (WPCPs), and (ii) carbon absorber operation does not generate additional pollutants, unlike thermal treatment which would generate nitrous oxides ( $\text{NO}_x$ ) emissions and possibly require the facility to comply with a more restrictive permitting category. It is anticipated that if required, air treatment will only be done on the exhaust, first-stage air strippers, as this is the where the majority of the contaminants will be removed. Alternative resin-based technologies will also be considered for off-gas treatment during the preliminary design.

Following the air strippers, final disinfection and chemical conditioning will occur within the contact basin. Chemical applications will include sodium hypochlorite ( $\text{NaOCl}$ ) for disinfection, sodium hydroxide ( $\text{NaOH}$  aka caustic) for pH control, hydrofluosilic acid ( $\text{H}_2\text{SiF}_6$ ) for fluoridation, phosphoric acid ( $\text{H}_3\text{PO}_4$  aka orthophosphate) for corrosion control. If in the future the DEP converts to chloramination for residual disinfection, then aqueous ammonia ( $\text{NH}_3$ ) would also be required for final conditioning.

Wastewater from the greensand filter backwash will be directed to an equalization basin, which will control the surge of backwash water coming from the greensand filter and provide a constant flow to the clarifier. Sludge withdrawal from the clarifier will be discharged to the sanitary sewer system, while the clarified waste water will be routed to a recycle well and pumped back into the detention basin (approximately 5% of the flow going through the treatment train).

### 3.7 Potential Impact on Water Quality from the Distribution System:

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possible chemical feed adjustments may also be required depending on the variability of well production. This is not anticipated to be a problem as the site is currently manned.

#### **4.4 Architectural & Community Concerns:**

Off-site impacts, including aesthetics, noise, air, and others, will be considered during the course of design. Architectural treatment of new structures will be included with the final design. The architectural treatments will likely include screen walls around the aerators, air stripping towers and potential vapor phase treatment, to aid in dampening noise from these systems, while also shielding the public's view. Other potential dual usages of the site will be investigated, including the development of a small education center for the community. Arts Commission and community board reviews will be incorporated as required.

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### **5.0 Design Criteria**

#### **5.1 Potential Conceptual Design Criteria**

The following listing includes design criteria which will be used to develop conceptual and preliminary designs for the site.

##### **5.1.1 Water Supply**

The wells shall be redeveloped in accordance with New York State Department of Health (NYSDOH) regulations and Recommended Standards for Water Works (a.k.a. Ten State Standards).

##### **5.1.2 Water Treatment**

The following sections outline the process flow schematic of the Station 6 water treatment plant, which is expected to treat 9 MGD as a start-up Demonstration Plant.

##### ***Aeration:***

The influent raw water from the wells will first go through the forced draft aerators, which are designed to raise the water's pH, oxidize the iron fully and manganese partially, and provide nominal VOC removal. Two aerators, each with a capacity of 3125 gpm, will be installed to treat the incoming 6250 gpm of flow.

##### ***Detention Basin:***

After exiting the forced draft aerators and receiving chemical treatment (sodium hypochlorite and caustic for additional oxidation and pH control), the flow is routed to two parallel detention basins. Each basin will be designed for a detention time of 30 minutes, with a

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design channel velocity of 10 ft/min. Four treated water pumps with 3 MGD capacity each will direct the water to the greensand pressure filters.

*Greensand Filters:*

With a filter rate of 3 gpm/sf, a total of five greensand filters will be required. Each filter will be 46 feet in length and 10 feet in width. An alternative would be to provide seven - 30 foot long, 10 foot diameter filters. A constant feed of potassium permanganate (a small amount) prior to the flow entering the greensand will allow the filter to regenerate. The backwash rate will be approximately 15 gpm/sf while the air/water wash rate will be approximately 5 gpm/sf. The expected run length of the backwash will be 9 hours; the source of the backwash water will be supplied by the on-line units.

*Packed Air Stripping Towers:*

Four 12-foot diameter packed air column strippers will be used to treat the groundwater for VOC removal. Air-water ratios will depend on the stage of the air-stripping process: the first stage (two towers) is expected to have an air-water ratio of 40:1 to remove the more 'strippable' VOCs, while a second phase of air strippers (two additional towers) will have a much higher air-water ratio (150:1) to remove the much less strippable VOCs, such as MTBE, that are not removed by the first stage.

*Vapor-Phase Carbon Adsorbers:*

Dual-bed activated carbon systems could provide 99 percent removal of VOCs in the off-gas stream from the air strippers. Standard design criteria is 50 - 60 cfm per sf of vessel area to alleviate excess backpressure. Hence, an air stripper with a 16,700 cfm exhaust flowrate would require approximately 230 sf of vessel surface area, which is equivalent to two vessels with a 12 ft diameter. Only the first-stage packed towers will be fed to the carbon adsorbers. With no vapor phase treatment of the aerators, a total of 8 12 ft. diameter vessels will be used.

*Contact Basin:*

Two contact basins, each with 4.5 MGD capacity and effective contact time of 30 minutes, will provide the sufficient contact time for disinfection. The contact basins are expected to have an overflow rate of 6600 gpm.

*Chemical Treatment:*

Chemical treatment will be applied along the process train. Sodium hypochlorite and caustic will be added prior to the flow entering the detention basins. A constant feed of potassium permanganate (a small dosage) will regenerate the greensand filters and also be applied prior to the basin. A second caustic feed will raise the pH further as the treated water enters the pressure filters. Sodium hypochlorite will oxidize the iron and manganese in the detention basin and will disinfect the water in the detention basin. After filtering and air stripping, disinfection will be provided through the addition of hypochlorite. The addition of orthophosphate (phosphoric acid) will provide corrosion protection while the addition of caustic will help raise the pH to match the pH in the distribution system. The finished water

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## **7.0 Project Implementation**

### **7.1 Additional Studies**

As stated above, a significant sampling effort is recommended before proceeding with the preliminary design. Many of the design parameters of the Demonstration Plant are currently based on data that is more than 15 years old is known to be incomplete. This sampling effort should include a minimum of 1 week of pumping at each of the wells which is proposed to be included with the modifications. At a minimum, daily sampling should be done during the one week period. Analysis of the samples shall include metals, water chemistry parameters, and VOCs. Additional samples shall be taken at the end of the one week pumping period for possible bench scale studies. These studies could include buffering capacity, aeration testing, and chemical precipitation depending on the contaminants of concern within the water. These tests would help further refine chemical feed and process criteria.

In addition to bench scale testing, it may be desirable to pilot test the proposed treatment process at a number of the wells. This may be done as part of the redevelopment process for the wells to provide results of the effectiveness of the proposed process train prior to final design.

### **7.2 Project Schedule**

The attached schedule shows the proposed design, review, and construction periods which are anticipated for this project. Please note that preliminary design of the facility is not recommended to begin until after the the water quality sampling and analysis described above has been completed.

### **Attachments**

#### **Distribution:**

NYC: D. Wuerdeman	D. Cohen	D. St. Germain	P. Glus
NNJ: T. Lane	J. Isbister		
Env. Review:	R. Gilmour & L. Wordsman		
QAM Review:	T. Dill, B. Behar, & M. Wooden		
TDD Review:	H. Wasserman & G. Cline		

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